

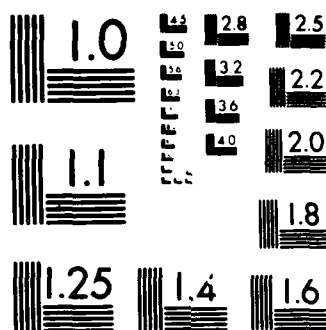
AD-A191 878 EFFECTS OF STATISTICAL DEPENDENCE IN RELIABILITY AND  
MAINTAINABILITY OF DEGRADABLE SYSTEMS(U) ILLINOIS UNIV  
AT URBANA K JORG-DEV 30 SEP 87 AFOSR-TR-88-0035  
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<p>A monograph entitled, "Unimodality, Connexity and Applications" was written. It provides a systematics approach to important tools in reliability. Other results include a sharpening of Tchebyshev's inequality and development of dependence concepts for reliability.</p>					
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## FINAL TECHNICAL REPORT FOR THE GRANT AFOSR - 84 - 0208

Kumar Joag-dev

*University of Illinois at Urbana-Champaign***I. Major Research Project**

Monograph "Unimodality, Convexity and Applications" was written during the last three years. The work consists of important tools used in Reliability Theory. This is the first time this has been done in a systematic fashion. Particular chapters directly connected with applications are "Unimodality and Statistical Dependence" and "Convexity and Theory of Reliability". The page-proofs are being proofread currently and the Academic Press is planning to have it published by April or May of 1988.

**II Other Research Articles**

1. *Some results on generalized unimodality and its applications to Tchebyshev type inequalities.* The article uses a generalized concept of unimodality introduced by Olshen and Savage (1970, J. Applied Prob.) to sharpen Tchebyshev's inequality. The improvement depends on the index  $\alpha$  of the unimodal distribution where the case  $\alpha = 1$  corresponds to usual unimodal distribution. Using similar notions for the bivariate case an improvement is obtained for the Tchebyshev type inequality due to Berge (1937). For the case of discrete distributions an analog of the notion of  $\alpha$ -unimodality is discussed.

The article has appeared in the *Proceedings of the Conference on Reliability Theory and Quality Control* held at Columbia, Missouri, pp. 127-132

2. *The Gauss Tchebyshev inequality for Unimodal distributions.* The main result pertains to bounds for the probabilities of a random variable deviating from arbitrary values (not necessarily the mean or the mode). A result of Gauss considered deviations from the mode where unimodality was assumed and obtained a bound sharper than the one given by Tchebyshev's inequality. Recently, assuming unimodality, Vysochanski and Petunin (1979, Th. of Prob. and Math. Stat.) considered deviations from the mean while retaining the improvement of the bounds. Besides simplifying the proofs, the main feature of our results is that deviations from arbitrary points are considered. This has a possible application in Quality Control. If the distribution of the statistic is such that the target value is different than the usual central value such as mean or mode, the bounds for the probabilities of deviations from the target value would help in determining the tolerance limits.

The article has appeared *Theory of Prob. and Its Applications*, vol. 30, pp. 817-820.

3. *Examples of Nonunique Maximum Likelihood Estimators.* The paper presents a class of examples in which, for samples of size  $n > 1$ , the possible

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maximum likelihood estimators do not form an interval. The key condition used is that of log convexity at one point.

The article has appeared in the *American Statistician*, vol. 39, pp. 199-200.

(Research Work mentioned above was done with the consultant S. Dharmadhikari)

4. *Dependency Concepts in Reliability Theory*, (with N.R. Chaganty). This is a chapter written for the Reliability Volume of *Handbook of Statistics* (P.R. Krishnaiah, editor). The chapter provides a comprehensive review of the recent work in the area of concepts of dependence.

5. *MAD Property of Median: A simple proof*. The article gives a very simple proof of one of the basic properties of the sample median, namely that it minimizes the mean absolute deviation. The proofs currently used in the literature are quite cumbersome in comparison.

6. *A Negative Result about some concepts of Negative Dependence*. The article shows that the condition of log concavity used to prove certain results about 'negative association', cannot be dropped.

The article is submitted to *Sankhya*.

7. *A Covariance Inequality for Coherent Structures*. The article extends a basic covariance inequality to associated random variables and at the same time simplifies the proof substantially.

The article is submitted to *American Statistician*.

(Above two articles represent joint work with Frank Proschan.)



### III Research Articles Under Preparation.

1. *A version of an Inequality for Ising Model with an application*. Karlin and Rinott (1981. *Ann. Stat.*) proved an important dependence property of the absolute values of random variables having joint normal distribution and zero means. One of the important steps involves rather lengthy computation. We show that the required result can be obtained rather easily by obtaining an extension of an inequality due to Kelly and Sherman. This extension might have other applications.

2. *Negative Dependence through Conditioning of Order Statistics*. A recent article by Block, Bueno, Savits and Shaked (1987 *Naval Res. Log.*) shows that

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certain probability inequalities play important role in obtaining bounds for the residual lives in certain reliability systems. We provide an alternative approach to their main theorem showing that it follows from some simple monotonicity results.

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